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POTATO BROWN-ROT.

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WHAT IS POTATO BROWN-ROT?

Brown-rot, or southern bacterial wilt, of the potato is a disease which is caused by bacteria.¹ Not only do affected plants wilt and die, but the tubers from such plants decay, either in the field, in storage, or in transit. So far as is known, no variety of potato is immune. The organism also attacks eggplant, pepper, tomato, tobacco, jimson weed, black nightshade, peanut, and other plants. It is known to have been particularly destructive in tomato fields in the South during past years.

¹ The bacterium which causes this disease is known as *Bacillus solanacearum*. A bacterium (plural, bacteria), like other fungi (singular, fungus), is a small simple plant which lacks the green color found in more complex plants, such as our orchard, field, and garden crops. Molds, yeasts, toadstools, and mushrooms are good examples of fungi. Fungi can not make their own food as green plants do, and many of them obtain it from living plants or their dead remains. Most fungi which obtain their food and energy from living plants are known as parasites, while the plants upon which they grow and feed are known as their hosts. Such fungi usually cause harmful changes in the structure, composition, and activities of their hosts, which are known as lesions. Such lesions constitute disease. Thus, in brown-rot of the potato the organism *Bacillus solanacearum* is the parasite which attacks and feeds upon its host, the potato, causing the wilting of the plant and brown-rot of the tuber, which are manifestations of the disease.

NOTE.—This is one of a series of circulars which deals with those phases of plant disease that are of importance in the marketing and distribution of vegetables; the production phases are discussed only in so far as they have bearing upon the problems of transportation and storage. Although some new disease data obtained in the investigation of market problems are presented, each circular is primarily a summary of relevant published material. Special attention is given to those factors which determine inception, development, and spread of disease in the field, in transit, and in storage. This is done so as to give growers, shippers, carriers, distributors, receivers, and storage men a basis for bringing about better production, marketing, distribution, transit, and storage practices with a corresponding reduction of waste.

WHAT IS THE EFFECT OF THE DISEASE ON THE POTATO TUBER?

Brown-rot may be indicated externally by a slight depression at the point of attachment of the stolon to the tuber, or by grayish brown discolored patches on the surface. Sometimes no external symptoms are visible. Upon cutting across infected tubers a moist brown discoloration and slight softening of the water-conducting ring tissues (vascular tissues) of the tuber are seen. Frequently, though not invariably, yellowish white sticky globules of bacteria ooze out from the discolored ring tissues (Pl. I). At this stage the rot is odorless.

This discoloration of the vascular tissues should not lead the observer to confuse this disease with that caused by the *Fusarium* blight or wilt organism. The latter is most common in potatoes from central and western points, while brown-rot is chiefly confined to the southern-grown crop.

As time goes on the bacteria work toward the center of the potato, the entire inner portion becoming soft and brown, while a thin outer crust holds the tuber together. If the rot reaches this advanced stage while the tuber is still in the soil, the shell is usually broken when the potatoes are dug, and the bacteria-filled contents are left in the soil. If the rot reaches this stage during the period of transit or while the potatoes are in storage, neighboring tubers are likely to become smeared with the rotten contents (Pl. II). In the later stages of the disease, other organisms of decay gain entrance, the central tissues are converted to a creamy consistency, and an indescribably foul odor results.

WHAT IS THE EFFECT ON THE PLANT?

The brown-rot is at first marked by wilting of the plant, which has led to the use of the descriptive name bacterial wilt. The symptoms of the disease as it affects the plant have been described by Dr. Erwin F. Smith as follows:

- 1 The first indication of this disease, or at least one to attract the farmer's attention, is the sudden wilting of the foliage. This may occur first on a single shoot, but finally it affects the whole plant (Pl. I). Subsequently, and especially if the plant is young and not very woody, the stem shrivels, first changing to a yellowish green or to a muddy green and finally to brown or black. The vascular bundles become brown long before the shriveling takes place and in the potato often show through the outer green parts of the stem as long dark streaks, or the bacteria run out on the petioles (leaf stems), forming narrow black lines. The vessels of such bundles are filled with the bacteria, which ooze out when the stem is cut across. The foliage may wilt with or without a preliminary yellowing. If the bacteria are abundant in the vessels of the stem, the wilt is often sudden and the foliage has not time to become yellow.

WHEN AND WHERE DOES THE DISEASE OCCUR?

Brown-rot, or bacterial wilt, occurs most frequently in the warmer sections of the United States and for this reason is often referred to as "southern bacterial wilt." The bacterium which causes the disease seems to be native to some of the virgin soils of our South Atlantic Coast and Gulf States. Consequently the disease is important, especially in potatoes grown on new land in Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, and Virginia. The disease is not limited to the United States, however, for reports of serious losses come also from the Tropics.

Under transit conditions brown-rot is a common and frequently a serious factor in shipments of the early or new crop from States on the Gulf and South Atlantic seaboard. Since practically none of this crop goes into storage, the disease is of little importance as a storage rot.

WHERE AND HOW DOES BROWN-ROT GET STARTED IN THE FIELD?

Brown-rot is not carried into the field on the seed piece. As has already been pointed out, it is of importance only in the Southern States. As practically all the seed potatoes planted in this territory are purchased in Northern States in which the disease does not occur, the introduction of brown-rot by means of infected seed stock is not likely to take place.

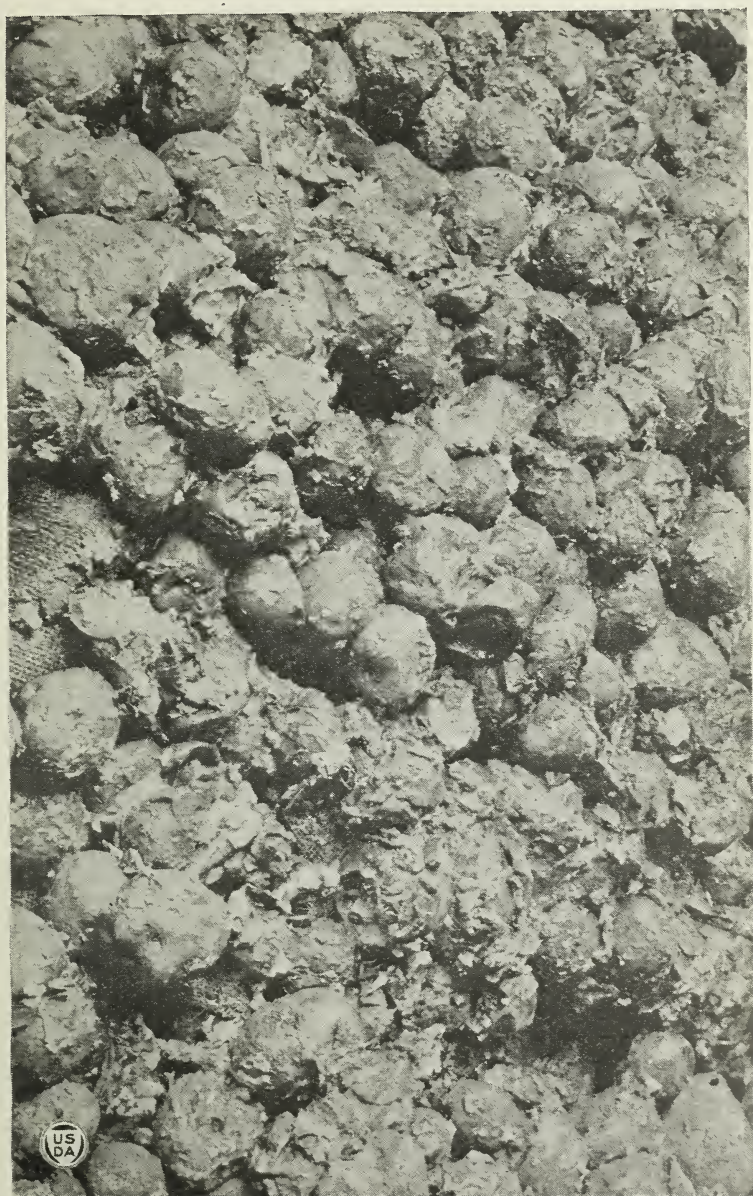
The bacterium which causes brown-rot seems to occur in certain virgin soils of the South. This statement is based on observations to the effect that the disease occurs in potato crops grown from disease-free seed in soil which never produced potatoes—in fact it is most severe in potato crops grown on new soil and diminishes in frequency and severity the longer the soils are cultivated and cropped.

The bacteria when present in the soil apparently attack the roots and underground stems of potato plants and thus gain entrance to the conducting tissues, along which they travel or are carried into all parts of the plant. They thus get into the above-ground parts of the plant, as well as into the stolons and tubers, killing and disintegrating first the conducting and later the adjacent tissues, and induce wilting and death of the plant either by clogging the water-conducting tissues or by actually destroying these and adjacent tissues.

If the soil is free from brown-rot, the organism may be carried into the field by insects from diseased plants in near-by fields. Once a single plant in the field has become diseased, other plants in that



ABOVE, POTATO PLANT IN THE EARLY STAGES OF BROWN-ROT. BELOW, SECTIONS OF TUBERS AFFECTED WITH BROWN-ROT. NOTE THE DIS-COLORED RING TISSUE ON WHICH OCCASIONAL CREAMY MASSES OF BACTERIA ARE PRESENT.



REPRODUCTION OF A PHOTOGRAPH TAKEN AT THE MARKET, SHOWING POTATOES WHICH HAVE ROTTED IN TRANSIT AS A RESULT OF BROWN-ROT INFECTION. HEALTHY POTATOES WHEN PRESENT OFTEN BECOME SMEARED WITH THE ROTTEN! FOUL-SMELLING CONTENTS.

field and adjacent fields are in danger, unless the leaf-eating insects are held in check. For example, the Colorado potato beetle spreads the disease by carrying bacteria on its jaws from wilted to healthy plants. It is reported that when these beetles which had fed on diseased plants were placed on healthy tops and permitted to feed, symptoms of the wilt were evident seven to nine days later. While it is probable that flea beetles, blister beetles, and other potato insects may distribute brown-rot, this matter has not yet been fully investigated. Neither is it known whether the bacteria can gain entrance to the plant or tuber through the uninjured skin.

WHERE AND HOW DOES BROWN-ROT GET INTO TUBERS?

As has been explained, the bacteria spread along the conducting tissues of a diseased plant. Consequently, irrespective of whether the plant became infected from the soil or in its above-ground parts, the disease may spread throughout the entire plant if conditions are favorable for its development, and reach the new tubers, entering at the stem end. It is for this reason that diseased tubers when cut across show a discoloration of the ring tissues and that sticky globules of bacteria frequently ooze out of the discolored tissues during the early stages of the trouble (Pl. I). Knowing that the bacteria enter the tubers from the diseased mother plant, it is readily understood how destruction of the vines and early digging, when these measures can be applied before the bacteria enter the tubers, may save a large portion of the crop. A very short time is required, however, for the disease to spread through the entire plant and into the tuber. In a greenhouse experiment, three weeks after symptoms of the disease were evident on the potato plant, the tubers were found to be entirely or partly rotted.

WHAT CONDITIONS FAVOR DEVELOPMENT AND SPREAD OF THE DISEASE?

Planting in certain virgin soils in the South and warm, moist weather favor the development of the disease. The organism grows well at temperatures ranging from 77° to 97° F. As the temperature is reduced, the organism's growth is retarded and practically stops at approximately 55° F. It is killed by a 10-minute exposure at 126° F., but is not readily destroyed by low temperatures. The disease, consequently, can not develop at temperatures below 55° F. and develops most rapidly at temperatures between 77° and 97° F. It seems to progress more rapidly in young plants than in older ones.

Undoubtedly spread of the disease in a field containing diseased plants is brought about by the presence of potato leaf-eating insects.

DOES BROWN-ROT OF THE TUBERS DEVELOP AND SPREAD AFTER HARVEST?

When conditions have been favorable for the development of the disease in the tops and infection is widespread, the tubers when harvested will show various stages of brown-rot. Some will be soft-rotted and will break up in the soil, leaving slimy masses of bacteria to live over and possibly infect subsequent crops of potato, eggplant, and tomato. There will be other tubers that are in the initial stages of the trouble, and it is probable that these will be marketed with sound stock. Unless the temperature during transit or storage is held at or below 55° F., such potatoes will rot very rapidly. Other organisms of decay usually enter and produce slimy, sticky, foul-smelling rots which destroy affected potatoes and smear neighboring healthy tubers with slime to such an extent that sound stock is sometimes discarded by mistake as worthless (Pl. II).

It is not known to just what extent sound potatoes resist infection when, as a result of contact with other tubers, they become contaminated with the slimy, soft-rot bacteria which follow brown-rot. However, decay will spread to adjacent potatoes during transit or storage in case they have been cut, bruised, or injured in such a way as to permit infection to occur. Immature, badly feathered stock, especially when shipped under moist conditions, is thought to be especially susceptible to infection, not only by the brown-rot organism but by the soft-rot bacteria as well.

Tubers that are known to be diseased, even though the trouble may be only in the initial stages, should not be stored or shipped, for such potatoes rot very quickly at temperatures above 55° F. (Pl. II). As it is practically impossible to discover and remove all tubers that are in the early stages of the disease, potatoes from affected fields should be used immediately or else shipped to near-by consuming points, or stored under cool, dry conditions, with provision made for the best ventilation.

HOW CAN THE DISEASE BE CONTROLLED IN THE FIELD AND IN STORAGE?

Satisfactory control measures can hardly be recommended until more is known about this disease. The most serious attacks of southern bacterial wilt apparently occur on virgin soils, and growers when planting under these conditions should realize the attendant risk. The question as to whether or not continuous potato cropping on the same fields tends to increase the chances of disease needs investigation. Some Florida growers have reported that with continuous cropping the danger of brown-rot diminishes.

It is not known to just what extent the widespread presence of the disease in a field may be due to insect transmission, as compared with underground infection from the soil. It is known, however, that leaf-eating or puncturing insects can carry the disease from affected plants to healthy ones, and as insect control is a part of good potato culture, it is recommended that attention be given to this point. Farmers' Bulletin 868, *How to Increase the Potato Crop by Spraying*, gives full directions for the control of insect pests. If practicable, when isolated diseased plants are found they should be promptly removed and burned.

In case the disease becomes widespread in the potato field and the stock is sufficiently mature to be dug, a portion of the potatoes may be saved by early harvesting, thus removing them before the bacteria have worked down into the tubers. If such stock is used immediately or stored in a dry, cool place, much wastage can be prevented.

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